

Claim Amendments

Please cancel claims 1, 2, 18, 19, 24 and 26, and amend claims 3, 4, 6, 8, 15, 20-23, 25 and 27-30 as follows:

- 5        1. (canceled) ~~A method for motion estimation in coding video data indicative of a video sequence including a plurality of video frames, each frame containing a plurality of coefficients at different locations of the frame, said method comprising:~~  
~~selecting at least one reference frame for a given original video frame;~~  
~~partitioning said original video frame into rectangular blocks of coefficients;~~  
10      ~~forming at least one reference block of coefficients from an offset of the rectangular blocks;~~  
~~computing the differences between said at least one reference block and the rectangular blocks; and~~  
~~optimizing the offset.~~
- 15      2. (canceled) ~~The method of claim 1, wherein said selecting comprises:~~  
~~obtaining M video frames for providing M references frames, wherein M is a positive integer greater than or equal to one.~~
- 20      3. (currently amended) The method of claim [[2]] 4, wherein said forming comprises:  
          for each of said rectangular blocks of coefficients and each permutation of a horizontal offset value X and a vertical offset value Y, obtaining M additional rectangular blocks of coefficients for providing M reference blocks, wherein each of said M reference blocks of coefficients is formed by selecting coefficients from the M reference frames, such
- 25      that the coefficients in the M reference blocks of coefficients are horizontally offset by distance X and vertically offset by distance Y from a corresponding coefficient in said rectangular block of coefficients.
- 30      4. (currently amended) ~~The method of claim 3 wherein said computing comprises: A method, comprising:~~

selecting M reference frames for a given original video frame from a video sequence having a plurality of video frames, each frame containing a plurality of coefficients, wherein M is a positive integer greater than 1;

partitioning said original video frame into rectangular blocks of coefficients; and

5 from each of the M reference frames:

forming at least one reference block of coefficients from an offset of the rectangular blocks; and

obtaining a block difference at least partially based on a summation of absolute values of differences between corresponding individual coefficients in for each of said M reference blocks, obtaining the difference between in each of said rectangular block blocks of coefficients and each said at least one reference block of coefficients for providing a block difference at least partially involving summation of the differences between corresponding individual coefficients in each block; and

optimizing the offset at least partially based on the block difference.

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5. (original) The method of claim 4, wherein said optimizing comprises:

for each of said rectangular blocks of coefficients, determining an optimal horizontal offset X and vertical offset Y, wherein said determining is based at least partially on minimizing a weighted sum of M block differences.

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6. (currently amended) The method of claim [[2]] 4, wherein each of the M video frames selected as the M reference frames is computed based on the same frame of original video.

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7. (original) The method of claim 4, wherein the block differences for the M reference blocks are combined for providing a weighted sum having a plurality of weighting factors, and wherein each weighting factor in the weighted sum is determined at least partially based upon a quantizer parameter or the index of the reference frame subjected to that weight.

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8. (currently amended) The method of claim [[2]] 4, wherein each of the M video frames selected as the M reference frames is computed by decoding the same frame of original video at a variety of quality settings.

9. (original) The method of claim 5, wherein motion is represented by a motion vector to be encoded in bits, and wherein said determining is also based on the number of bits needed to encode the motion vector.

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10. (original) The method of claim 5, wherein the set of M reference frames is divided into N sub-sets, such that each of the M reference frames belongs to precisely one of the N sub-sets, and wherein the process of determining the optimal horizontal offset X and vertical offset Y is repeated for each of said N sub-sets of reference frames, for indicating a set of N optimal horizontal offsets X and N vertical offsets Y.

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11. (original) The method of claim 5, wherein said determining of the optimal horizontal offset X and optimal vertical offset Y involves a discrimination against offsets with large magnitudes.

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12. (original) The method of claim 11, wherein the discrimination is at least partially dependent upon an index corresponding to which of the M reference frames is being considered.

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13. (original) The method of claim 10, where the number N may vary from one frame of video to another frame of video.

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14. (original) The method of claim 11, where the number N may vary from one frame of video to another frame of video, and the determination of the number N involves analysis of block differences in the previous frame.

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15. (currently amended) The method of claim [[3]] 4, wherein for each rectangular block, the set of M reference blocks is divided into N sub-sets, such that each of the M reference blocks belongs to precisely one of the N sub-sets, and wherein the process of determining the optimal horizontal offset X and vertical offset Y is repeated for each of said N sub-sets of

reference blocks, for indicating a set of N optimal horizontal offsets X and N vertical offsets Y.

16. (original) The method of claim 15, wherein the number N of sub-sets may vary from one block to another within the given frame of video, said variation either based upon explicit signaling in the encoded bit stream or upon a deterministic algorithm.

5           17. (original) The method of claim 16, wherein the size of a rectangular block in one of the N sub-sets is computed at least partially using the size of a rectangular block in another of the 10 N sub-sets or the values of the horizontal offsets X and vertical offsets Y.

18. (canceled) ~~A coding device for coding video data indicative of a video sequence including a plurality of video frames, each frame containing a plurality of coefficients at different locations of the frame, said device comprising:~~

15           ~~— a motion estimation module, responsive to an input signal indicative of an original frame in the video sequence, for providing a set of predictions so as to allow a prediction module to form a predicted image; and~~

~~— a combining module, responsive to the input signal and the predicted image, for providing residuals for encoding, wherein the motion estimation block comprises a mechanism for carrying out the steps of:~~

~~— selecting at least one reference frame for a given original video frame;~~

~~— partitioning said original video frame into rectangular blocks of coefficients;~~

~~— forming at least one reference block of coefficients from an offset of the rectangular blocks;~~

25           ~~— computing the differences between said at least one reference block and the rectangular blocks; and~~

~~— optimizing the offset.~~

19. (canceled) ~~The device of claim 18, wherein the step of selecting comprises the step of: obtaining M video frames for providing M references frames, wherein M is a positive integer greater than or equal to one.~~

20. (currently amended) The device of claim [[19]] 21, wherein ~~the step of said~~ forming comprises ~~the step of:~~

5        obtaining M additional rectangular blocks of coefficients for providing M reference blocks, for each of said rectangular blocks of coefficients and each permutation of a horizontal offset value X and a vertical offset value Y, wherein each of said M reference blocks of coefficients is formed by selecting coefficients from the M reference frames, such that the coefficients in the M reference blocks of coefficients are horizontally offset by distance X and vertically offset by distance Y from a corresponding coefficient in said 10      rectangular block of coefficients.

21. (currently amended) ~~The device of claim 20, wherein the step of computing comprises the step of:~~ An encoder, comprising:

15      a motion estimation module, responsive to an input signal indicative of an original frame in a video sequence, for providing a set of predictions so as to allow a prediction module to form a predicted image, wherein the video sequence including a plurality of video frames, each frame containing a plurality of coefficients at different locations of the frame; and

20      a combining module, responsive to the input signal and the predicted image, for providing residuals for encoding, wherein the motion estimation block is configured for selecting M reference frames for a given original video frame in said plurality of video frames, wherein M is a positive integer greater than 1;

25      partitioning said original video frame into rectangular blocks of coefficients; and from each of the M reference frames:

30      forming at least one reference block of coefficients from an offset of the rectangular blocks; and

obtaining a block difference at least partially based on a summation of absolute values of differences between corresponding individual coefficients in for each of said M reference blocks, the difference between in each of said rectangular block blocks of coefficients and each said at least one reference block of coefficients for providing a block

~~difference at least partially involving summation of the differences between corresponding individual coefficients in each block; and~~

optimizing the offset at least partially based on the block difference.

- 5 22. (currently amended) The device of claim 21, wherein ~~the step of~~ said optimizing comprises ~~the step of~~:

determining, for each of said rectangular blocks of coefficients, an optimal horizontal offset X and vertical offset Y, wherein said determining is based at least partially on minimizing a weighted sum of M block differences.

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23. (currently amended) A computer readable medium having embedded therein a software program for use in motion estimation in coding video data indicative of a video sequence including a plurality of video frames, each frame containing a plurality of coefficients at different locations of the frame, said software program comprising:

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- ~~a code for selecting at least one reference frame for a given original video frame;~~
- ~~a code for partitioning said original video frame into rectangular blocks of coefficients;~~
- ~~a code for forming at least one reference block of coefficients from an offset of the rectangular blocks;~~

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- ~~a code for computing the differences between said at least one reference block and the rectangular blocks; and~~
- ~~a code for optimizing the offset~~ programming codes for carrying out the method according to claim 4.

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24. (canceled) The ~~software program of claim 23, wherein the code for selecting said at least one reference frame comprises:~~

- ~~a code for obtaining M video frames for providing M references frames, wherein M is a positive integer greater than or equal to one.~~

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25. (currently amended) The ~~software program computer readable medium~~ of claim [[24]] 23, wherein said the code for forming said at least one reference block comprises:

a code for obtaining M additional rectangular blocks of coefficients for providing M reference blocks, for each of said rectangular blocks of coefficients and each permutation of a horizontal offset value X and a vertical offset value Y, wherein each of said M reference blocks of coefficients is formed by selecting coefficients from the M reference frames, such  
5 that the coefficients in the M reference blocks of coefficients are horizontally offset by distance X and vertically offset by distance Y from a corresponding coefficient in said rectangular block of coefficients.

10 26. (canceled) The ~~software program~~ computer readable medium of claim 25, wherein the code for computing the differences comprises:

15 ~~a code for obtaining, for each of said M reference blocks, the difference between said rectangular block and each said reference block of coefficients for providing a block difference at least partially involving summation of the differences between corresponding individual coefficients in each block.~~

20 27. (currently amended) The ~~software program~~ computer readable medium of claim [[26]] 25, wherein said the code for optimizing the offset comprises:

25 ~~a code for determining, for each of said rectangular blocks of coefficients, an optimal horizontal offset X and vertical offset Y, wherein the determination is based at least partially on minimizing a weighted sum of M block differences.~~

28. (currently amended) The ~~software program~~ computer readable medium of claim [[26]] 23, further comprising

30 ~~a code for combining wherein the block differences for the M reference blocks are combined for providing a weighted sum having a plurality of weighting factors, and wherein each weighting factor in the weighted sum is determined at least partially based upon a quantizer parameter or the index of the reference frame subjected to that weight.~~

29. (currently amended) The ~~software program~~ computer readable medium of claim [[27]] 23, wherein the set of M reference frames is divided into N non-overlapping subsets, and wherein the code for determining the optimal horizontal offset X and vertical offset Y repeats

the process for each of said N sub-sets of reference frames, for indicating a set of N optimal horizontal offsets X and N vertical offsets Y.

30. (currently amended) The ~~software program~~ computer readable medium of claim 25,  
5 wherein for each rectangular block, the set of M reference blocks is divided into N non-overlapping sub-sets, and wherein the code for determining the optimal horizontal offset X and vertical offset Y repeats the process for each of said N sub-sets of reference blocks, for indicating a set of N optimal horizontal offsets X and N vertical offsets Y.

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